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THE MESOZOIC AND CÆNOZOIC REALMS OF THE INTERIOR OF NORTH AMERICA.

BY E. D. COPE.*

IN the following pages all the sources of information on the subject in hand have been laid under contribution. Chief among these are the reports of the United States geological survey of the Territories under F. V. Hayden, the United States geological survey of the fortieth parallel under Clarence King, and the United States geological survey west of the one hundredth meridian under Captain G. M. Wheeler, United States Engineers. The association of the author with the first and last named of these surveys in the field, and the examination of large collections of vertebrate fossils made in the region reported on, furnish the opportunities in his possession.

The author does not recognize in the following pages a Quaternary division of geological time, but regards the present period as a continuation of the Cænozoic or Tertiary Realm, including all after the beginning of the glacial age under the name Plistocene.

MESOZOIC REALM.

This system is distinguished from the Palæozoic in North America, as to the Vertebrata, as follows:

Presence of Reptilia Dinosauria, Ichthyopterygia, Sauropterygia? Pterosauria, Testudinata, and Lacertilia; presence of Mammalia. Absence of Tunicata Antiarcha, Agnatha Arrhina, and Diplorhina,[2] of Pisces Placoganoidei, of Batrachia Ganocephala? Rhachitomi and Embolomeri,[3] and of Reptilia Theromorpha.[4]

From the Cænozoic system the Mesozoic differs in the presence of Reptilia Dinosauria, Sauropterygia, Ichthyopterygia; of Mammalia Marsupialia Multituberculata;[5] and in the absence of Pisces Actinopteri,[6] Nematognathi, and Plectospondyli; of Aves Insessores, and Mammalia Diplarthra[7] and Rodentia.

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* Read before the American Committee of the International Geological Congress at its meeting at Albany, April 6, 1887. The writer, previous to the adoption of the report of the proceedings of the committee for the previous year,[1] objected to the adoption of the word "group," as proposed by the Congress of Berlin, for the division of geological formations of first rank, and proposed to substitute the word "realm" therefor; *e.g.*, the Archæan, Palæozoic, Mesozoic, and Cænozoic Realms.

The primary systems of the Mesozoic are four, viz.:
Postcretacic,
Cretacic,
Jurassic,
Triassic.

TRIASSIC SYSTEM.

The vertebrate fauna is characterized by the presence of Reptilia Belodontidæ[8] and Aëtosauridæ, and of Mammalia Dromatheriidæ;[9] also by the absence of Dinosauria Opisthocœla,[10] Orthopoda, Parasuchia,[11] and Eusuchia; of Batrachia Anura and Urodela; of Saurodont and of Physoclystous fishes.

The division of the Trias into Muschelkalk and Keuper, so well marked in Europe, is not distinguishable in North America, our beds presenting the faunal characters of the Keuper or upper Trias of that continent. They, however, present two divisions which are lithologically distinct in Nevada, to which Mr. King[12] has given the names Koipato for the lower and Star Peak to the upper. The latter is of marine origin, while the Trias of the Rocky Mountains and of the Atlantic slope is lacustrine. The Rocky Mountain Trias is exposed upturned along both the eastern and western slopes of north and south ranges, and the north and south slopes of east and west ranges. In Nevada it forms the mass of the Havalla, Pah Ute, and West Humboldt ranges. Its thickness is, according to King,—

	Feet.
Colorado, east flank of mountains	300 to 1200
Nevada, Koipato bed	4000 to 6000
Nevada, Star Peak bed	10,000

Triassic beds probably also occur in the Indian Territory.*

JURASSIC SYSTEM.

The vertebrate fauna is characterized as follows:

Present: Reptilia Dinosauria Opisthocœla, Orthopoda, Mesosuchia; Testudinata Clidosterna; Ichthyopterygia Sauranodontidæ;[40] Batrachia Anura;[13] Mammalia ?Bunotheria.[14] Absent: Pisces Actinochiri, Saurodontidæ; Percomorphi; Dinosauria Belodontidæ; Reptilia Choristodera;[15] Aves Odontornithes; Mammalia Placentialia Ungulata, Creodonta, and Tillodonta.

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* Triassic formations have not yet been detected in Texas, those recently referred by Mr. Hill of the United States Geological Survey to that age being the Permian beds of the Red River. (See Amer. Jour. Sci. Arts, 1887, p. 302.)

The Jurassic bed constantly overlies the Triassic along the flanks of all the Rocky Mountain ranges, consisting of clays, shales, marls, and cherty limestones. In Colorado it has, according to King, a thickness of seventy-five to two hundred and fifty feet. It grows thicker westward, reaching seven hundred feet on the west flanks of the Sierra Madre, in New Mexico, and, according to King,[16] consists in Nevada of—

	Feet.
Slates	4000
Limestone	1500 to 2000

The forms of vertebrates found apparently together at this horizon are represented in Europe by genera of different subdivisions of the Jurassic. Hence it has not been possible to refer the Rocky Mountain beds to any of the latter, and Marsh has therefore designated them as the *Atlantosaurus* beds.[81]

A series of deposits lies between the Triassic and Cretaceous formations in the Middle Atlantic States, which have been supposed from the palæobotany to be of Jurassic age by Tyson.[17] What division, if any, of the European series they represent has not yet been ascertained, but they are regarded by Mr. McGee as belonging at the summit of the system. He names them the Potomac formation in an unpublished memoir.[18]

CRETACIC SYSTEM.

Characteristics.—Presence of Saurodont[19] and Actinochirous fishes; of Reptilia Eusuchia, Testudinata Protostegidæ, Propleuridæ, and Adocidæ; of Aves Odontornithes.[20] Absence of Pisces Ginglymodi[21] and Halecomorphi; of Reptilia Choristdera, Dinosauria Opisthocœla.

This formation has great extent and thickness in North America, and it displays a number of divisions, which differ both lithologically and faunally. These are the

Fox Hills,
Pierre,
Niobrara,
Benton,
Dakota,
Comanche.

THE COMANCHE has been recently named and described by Hill.[22] It consists principally of limestones of varying character which contain numerous marine invertebrata, which have been determined by White to represent a horizon of the Cretacic lower than the Dakota, and corresponding with some member of the Lower Cretacic of Europe. No vertebrates known. The formation is seen between the east and west Cross-Timbers of Texas, and the thickness is not given.

THE DAKOTA[23] has not yet produced vertebrate remains, but abounds in plants which have, according to Lesquereux,[24] the character of those of the Turonian or Lower Chalk of Europe, with an admixture of Miocene and recent types. Its beds consist of generally hard sandstone and conglomerate, and they occur almost everywhere along the flanks of the Rocky Mountain uplifts, forming distinct hog-backs. The thickness is from three to four hundred feet.

THE BENTON.—These beds consist of dark-colored clays, more or less shaly, and have a thickness of from two hundred to four hundred and fifty feet. They contain vertebrate fossils, mostly fishes in poor preservation. The only vertebrate type observed in it which gives it character is a crocodilian reptile, with flat articular vertebral faces, provisionally referred to the genus Hyposaurus.[25] The Benton formation is widely distributed, usually present where the Dakota occurs, and lying conformably on it, and from its soft material, forming valleys.

THE NIOBRARA.—Composed of harder and softer argillaceous limestones and chalky marls, varying from one hundred to two hundred feet in thickness.[29] The Niobrara is present with the Dakota and Benton on the flanks of the Rocky Mountains, but has also a wide extent east and southeast of them, forming a large part of The Plains, and other large tracts in Texas.[26] * It probably occurs in the valley of the Red River of the North. It is a deep-water formation, and is very rich in fossils, vertebrate and invertebrate. Characterized as follows:

Present: Pisces Isospondyli Saurodontidæ, and Actinochiri, Hemibranchi Dercetidæ;[27] Reptilia Sauropterygia with long necks; Pythonomorpha, except Mosasaurus; Testudinata Protostegidæ; Pterosauria Pteranodontidæ;[28] Aves Odontornithes. Absent: Reptilia Crocodilia Procœla; Pythonomorpha, Mosasaurus.

PIERRE.—Dark carbonaceous shales and clays, and dark-colored

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* See page 469 this number AMERICAN NATURALIST.

marls, which lie conformably on the Niobrara beds both on the flanks of the Rocky Mountains and on the northern parts of the Plains. Thickness (King), two hundred and fifty to three hundred feet.[29] Represented in the East, according to Meek and Whitfield, by the lower green-sand marl of New Jersey, Delaware, etc. Invertebrate fossils very numerous; vertebrates less numerous in the interior basin, more so on the Atlantic slope. The predominant genera in the two regions are Mosasaurus and Elasmosaurus, the latter occurring also in the Niobrara. The distinctness of this horizon from the latter on grounds of vertebrate palæontology depends chiefly on the fauna of the Eastern beds. The distinctions are,—

Presence of Reptilia Crocodilia Procœla; Pythonomorpha Mosasaurus.[30] Absence of Pisces Isospondyli Actinochiri; Pterosauria Pteranodontidæ; Aves Odontornithes.

It remains to be seen whether these differences will remain under future investigation.

Fox Hills.—Formed of sandstones more or less argillaceous, varying in thickness from thirty feet (Cope), Montana, to fifteen hundred feet (King), Colorado, to three thousand to thirty-five hundred feet in Southwest Wyoming (King).[29] The vertebrate fauna in the West is sparse, but in New Jersey it is very full. It is characterized in Montana by

Presence of Pisces Holocephali [31]; Haplomi (Ischyrhiza); Reptilia Pythonomorpha and Sauropterygia with short neck (Uronautes); [31] Crocodilia Procœla.

In New Jersey it has the same characters, with the additions,—

Present: Pisces Percomorphi Berycidæ; [32] Reptilia Testudinata Adocidæ and Pleurodira. Absent: Pisces Isospondyli Actinochiri.

Mr. King has combined the Benton, Niobrara, and Pierre into a single division, which he called the Colorado.[29] On palæontological grounds there is as yet no more reason for uniting these without than with the Fox Hills group. If the Fox Hills is retained as distinct, the others should be also. However, future research may change the present aspect of the case.

Total thickness of the Cretacic of the West, about four thousand nine hundred feet.

POSTCRETACIC SYSTEM.

This name was proposed and afterwards abandoned by White[33] for the lacustrine formations which rest conformably on the upper beds of the Cretacic (Fox Hills), whose palæontology will not permit them to be ranged with the Cænozoic system. The Vertebrata are as follows:

Presence of Pisces Ginglymodi and Halecomorphi; Reptilia Choristodera; Mammalia Marsupialia Multituberculata. Absence of Pisces Isospondyli Saurodontidæ and Actinochiri; of Reptilia Sauropterygia and Pterosauria.

There are two well-marked epochs of the Postcretacic,—the Puerco and the Laramie.

LARAMIE.—Present:[34] Pisces Elasmobranchi Myledaphus; Reptilia Dinosauria Goniopoda and Orthopoda. Absent: Mammalia Placentialia.

This formation has an immense extent on the northern plains in the United States[35] and Canada;[36] along the eastern flank of the Rocky Mountains, and on the western flanks of the same in New Mexico, and along the Lower Rio Grande in Texas and Tamaulipas.[37] It consists of sandstones, marls, and lignite, whose base rests conformably on the Fox Hills beds of the Cretaceous, when the latter is present. Thickness:

	Feet.
East flank of Rocky Mountains, Colorado (King)[38]	1500
Southwestern Wyoming (King)	5000
Upper Missouri, Montana (Cope)[31]	500
Northwestern New Mexico (Baldwin and Cope)[39]	2000

A formation has been observed along the Belly River, in Saskatchewan, by the geological survey of the Dominion of Canada, which they call the Belly River.[80] It is overlaid by the Pierre, and would be placed in the system in accordance with this position between that formation and the Niobrara below it. But the flora and the fauna, vertebrate and invertebrate, are identical, or nearly so, with that of the Laramie. The explanation of this singular state of the evidence has not yet been reached.

PUERCO.[41]—Present: Mammalia Placentialia. Absent: Pisces Elasmobranchi; Reptilia Dinosauria Goniopoda and Orthopoda.

The fauna[42] of this horizon is well distinguished from that of the Laramie in the absence of the numerous Dinosauria of the latter, and the presence of numerous Placental Mammalia in the former. On these grounds I at first referred the formation to the Cænozoic series, but further reflection induced me to place it as now arranged. The reason is as follows: Although Placental Mammalia are not now known otherwise from Mesozoic beds, the other forms of the Puerco are especially Mesozoic in character. Such are the Choristodere Reptilia and the Multituberculate Marsupialia, neither of which occur above, while both occur below the Puerco, the Multituberculata down to the Trias inclusive. Then the Placentialia are entirely peculiar in the absence of the Diplarthra and of the Rodentia,[39] orders always found in the Cænozoic beds. Then the characters of the Condylarthra and Amblypoda and many of the Creodonta, which represent Tertiary types, are so peculiar that we are led to suspect that when the Cretacic Mammalia are fully known they cannot differ very widely from those of the Puerco.

But one area of this formation is definitely known; this is in Northwestern New Mexico and Southwestern Colorado. It consists of sandstones and soapy marls, and has a thickness of eight hundred and fifty feet.[39] It is immediately overlaid by the Wasatch Eocene, and rests on the Laramie.

TOTAL THICKNESS of the Mesozoic system (greatest):

	Feet.
Triassic	16,000
Jurassic	6,000
Cretacic	4,900
Postcretacic	5,850
	31,750

CÆNOZOIC REALM.

This Realm is distinguished from the Cretacic, as well as from the Mesozoic formations as a whole, in North America by the following peculiarities. In Vertebrata:

By the presence of Diplarthrous Mammalia.
" " of Rodent "
" " of Nematognath Fishes.
" " of Plectospondylous Fishes.
" " of Osteoglossid "
" " of Pharyngognath "
" absence of Multituberculate Marsupial Mammalia.
" " of Orthopod and Goniopod Dinosauria.
" " of Choristodere Reptilia.

The primary systems of the Cænozoic Realm are
Plistocene,
Pliocene,
Miocene,
Eocene.

Although open to conviction, I have not perceived the necessity for the term Oligocene for a supposed system between the Eocene and Miocene. In America the faunal distinction between the latter is so marked as to render a third name, for the present at least, unnecessary.

The characteristic features of the faunæ of these divisions are as follows:

EOCENE.—*Mammalia.* Presence of Tillodontia, Tæniodontia, Mesonychidæ, Amblypoda, Condylarthra, and Lophiodontidæ. Absence of Carnivora, Ruminantia,* Proboscidia, Leporidæ, Palæotheriidæ (and Anthropomorpha Europe). *Pisces.* Presence of Osteoglossidæ and Gonorhynchidæ.

MIOCENE.—*Mammalia.* Presence of Carnivora, of Rhinocerontidæ, Leporidæ, Ruminantia,* and of Edentata. Absence of Tillodonta, Tæniodonta, Amblypoda, and Condylarthra.

PLIOCENE.—Presence of extinct families of Mammalia: Castoroididæ, Glyptodontidæ, Megatheriidæ, and Eschatiidæ, and of extinct genera, as Holomeniscus and Hippotherium.

PLISTOCENE.—*Mammalia.* All families are recent and most of the genera; many species also recent.

EOCENE SYSTEM.

The Eocene formations of the interior of North America are as follows:[43]
Uinta,
Bridger,
Wind River,
Wasatch.

These formations are clearly successive in their relations. There are two others, contemporary with one or more of these, whose characters are due to physical causes. They are the
Amyzon beds,
Green River shales.

They differ from each other in the following faunal peculiarities:

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* *I.e.*, quadritubercular Selenodont Artiodactyla.

WASATCH.[44]—*Mammalia.* Presence of Tæniodonta, Condylarthra, and Pantodonta. Absence of Tillodonta, Dinocerata, Palæosyops, Hyrachyus, Amynodon, Achænodon, Triplopus, and suilline and selenodont Artiodactyla.

This formation is characteristic of the region between the Rocky Mountains proper and the Wasatches, and has three principal areas. The most southern is in Northwestern New Mexico; the middle tract is in Southwestern Wyoming and Northeastern Utah; the third tract is in Northwestern Wyoming, on the Big Horn River.

	Feet.
Thickness in Northwestern New Mexico (Cope)	2500
Thickness in Southwestern Wyoming (Hayden)	1500
Thickness in Northwestern Wyoming (Wortman)	4000

WIND RIVER.[45]—*Mammalia.* Presence of Condylarthra, Tæniodonta, Pantodonta, Dinocerata, Palæosyops, and Hyrachyus.

This fauna indicates the transition between the Wasatch and Bridger, since types are here associated which are elsewhere peculiar to the two horizons named. Thus, of the above zoological divisions the following are exclusively Wasatch: Tæniodonta and Pantodonta. The remaining ones are Bridger, excepting the Condylarthra, which probably occurs in both Bridger and Wasatch.

This formation is known from one area, which is on the headwaters of the Wind River, near the middle of Western Wyoming. The formation is, according to Hayden, not less than five thousand feet in thickness.

Near the horizon of the Wind River beds must be placed the Green River Shales.[46] This formation intervenes between the Wasatch and Bridger beds in Southwestern Wyoming, and differs entirely from both in lithological and palæontological characters. It consists of more or less finely-laminated calcareous or calcareo-silicious shales, which have a depth of two thousand feet. The sedimentation has evidently been fine, indicating deep and still water. The Vertebrata obtained are almost exclusively fishes, two species of Crocodiles being the only exceptions. The fishes are clearly of Eocene character, and embrace some types (Gonorhynchidæ, Osteoglossidæ, and Chromididæ) now restricted to the Southern Hemisphere faunæ.[48] Two of these types, together with two other genera of fishes, occur in the Bridger beds; and the two last named (Clastes and Pappichtlys) are also found in the Wasatch. A probable second locality of this formation is known in Eastern Utah, in the Wasatch Mountains. The formation is known as the Manti beds.[47]

BRIDGER.—*Mammalia.* Presence of Tillodonta, ? Condylarthra, and Dinocerata, Hyrachyus, Palæosyops, Amynodon, Triplopus, and Achænodon. Absence of Tæniodonta, Pantodonta, and selenodont Artiodactyla.

Two divisions of this formation are sustained by Scott. These have been named the Bridger and Washakie respectively by Hayden. The former is represented by a single area, which is west of Green River, in Southwestern Wyoming. The latter is also known from but one area, which is also in Southwestern Wyoming, but is east of Green River. These divisions differ in the species they contain, very few, according to Scott, being common to the two. Amynodon is the only genus which in the Bridger seems to be confined to the Washakie division; perhaps Triplopus has the same distribution.

Another tract of the Bridger formation is known from Western Colorado, but to which of the two above divisions it is referable is unknown.

The depth of the Bridger proper is, according to King, two thousand five hundred feet. I have given that of the Washakie as about twelve hundred feet.

UINTA.—*Mammalia.* Presence of Amynodon and Selenodont Artiodactyla. Absence of Pantodonta and Dinocerata (Scott).

The facies of this fauna is more modern than that of the Bridger, and is clearly intermediate between it and that of the White River. One area is known, which is south of the Uinta Mountains, in the northeastern part of Utah. The thickness of the beds is not great, according to King.[49]

AMYZON BEDS.[50]—The exact horizon of this formation is not yet determined, but it is probably at the close of the Eocene or the opening of the Miocene. It is almost exclusively known palæontologically from fossil fishes, and these can be compared with those of the Green River shales. The characters are: Presence of Catostomidæ, Siluridæ, and Trichophanes. Absence of Osteoglossidæ, Gonorhynchidæ, and Chromididæ.

The only point of affinity with the Green River fauna is the presence of Trichophanes, which is nearly related to Amphiplaga of the latter.

There are three widely-separated localities of this formation. One is in the South Park of the Rocky Mountains, Colorado, another at Elko and Osino, in Northeastern Nevada, and the third is in Central Oregon, where it lies, according to Condon, immediately below the John Day formation.

MUTUAL RELATIONS OF THE EOCENE FORMATIONS.—Where the Bridger beds rest on the Wasatch, which I only know to be the case in the Washakie basin, in Wyoming, they are conformable. The Uinta beds are, on the contrary, not conformable to the Bridger beds, according to King.[51] The relations of the Wind River beds to the Wasatch remain undescribed.

MIOCENE SYSTEM.

The formations of the Miocene in the interior of North America are the following:

Loup Fork,
Ticholeptus,
John Day,
White River.

These horizons represent succession in time. A formation whose relation with the Loup-Fork epoch is yet uncertain has been named "The Dalles."[52] The four series each possess well-marked faunæ, whose distinguishing features are enumerated below.

WHITE RIVER.—*Mammalia.* Presence of a few Lemuroidea (?) and Creodonta, Amynodon (Scott and Osborn), Hyracodon, Cryptoproctidæ, Poëbrotheriidæ, Tragulidæ, Elotheriidæ, and Menodontidæ. Absence of Felidæ, Ursidæ, and Rodentia, except Sciuridæ and Leporidæ; of Camelidæ, Equidæ, and Proboscidia.[53]

There are three areas of this formation. The most extensive is the most southern, and occupies a large tract along the White River, in Northern Nebraska[35] and Southern Dakota, and extends westward into Wyoming and southwestward into Northeastern Colorado. The second is much smaller, and is situated in Central Dakota, two hundred miles north of the nearest point of the southern tract.[54] The northernmost White River formation is in Southern Canada, in the district of Assiniboia, and is intermediate in extent between the two previously-mentioned areas.[55] Some faunal differences have been noticed between these areas, which may be due to geographical distribution, imperfect observation, or slight difference of age. Thus, in the Central Dakota area, Hyænodon, Hyracodon, and Poëbrotherium have not yet been found. In the Canadian tract[57] neither of these forms has been found, and a genus of Creodonta (Hemipsalodon) is as yet peculiar to it. The thickness of the beds is as follows:

	Feet.
Nebraska (Hayden)[56]	150
Central Dakota (Cope)	200

The White River series corresponds to the Oligocene of some authors. Thus there occur in both Europe and America at this period the genera Elotherium, Hyænodon, Cynodictis, Ischyromys (= *Sciuromys* teste Schlosser in litt.), ? Pterodon (? *Hemipsalodon* teste Schlosser in litt.), and Agriochœrus (? *Haplomeryx*). Other European Oligocene genera occur in the John Day series, as Meniscomys (= *Sciurodon* teste Schlosser in litt.) and (? = *Aelurogale*) Archælurus (Schlosser in litt.).

JOHN DAY.—*Mammalia.* Presence of Nimravidæ, Poëbrotheriidæ, Tragulidæ, Elotheriidæ, Suidæ, Muridæ, and Saccomyidæ. Absence of Lemuroidea and Creodonta; of Hystricidæ, Felidæ, Ursidæ, Camelidæ, Equidæ, and Proboscidia.[53]

This formation occupies a considerable tract on the upper part of the course of the John Day River in Oregon. King states that it extends north into Washington and south into Nevada,[58] but, according to White, the beds from the latter State, to which King gave the name Truckee, are of later age. According to Marsh the John Day beds have a thickness of four or five thousand feet. The vertebrate fauna is very rich.

The beds in the valley of the North Fork of the John Day River present some faunal peculiarities, but their significance is unknown.[59]

TICHOLEPTUS.[59]—*Mammalia.* Presence of Anchitherium, Proboscidia, and Camelidæ, and the Oreodont genera Merycochœrus, Merychyus, Cyclopidius, and Pithecistes. Absence of ? Elotheriidæ, ? Poëbrotheriidæ, ? Nimravidæ, and Cosoryx.

This horizon requires further exploration, as but twenty species have been thus far determined from it. But it is evidently intermediate in age between the John Day and Loup Fork epochs, with greatest affinities to the latter.[60] It differs from the latter in the presence of Anchitherium and numerous genera and species of Oreodontidæ, and in the absence of Cosoryx. The formation is known from three regions: first, from Western Nebraska; second, from the valley of Deep River, Montana; and third, from Cottonwood Creek, Oregon. Its thickness has not yet been stated.

LOUP FORK.—*Mammalia.* Presence of Felidæ, Camelidæ, Equidæ, Proboscidia, Cosoryx, Glyptodontidæ, and Hystricidæ. Absence of Tragulidæ, Oreodontidæ (with very few exceptions), Poëbrotheriidæ, Elotheriidæ, and Nimravidæ.

This formation has a wide extent throughout North America. The largest area overlies the White River[61] beds in Nebraska, Wyoming, and Colorado,[62] extending south and east of that formation into Kansas,[63] where it rests on the Cretaceous. There is a second area in Northern Central New Mexico,[64] and one perhaps in Southern New Mexico, extending from the Rio Grande to near the Arizona border.[65] There is another tract in Washington County, Texas; and yet another in Mexico, on the boundaries of the states of Hidalgo and Vera Cruz.[79] According to King its thickness in Wyoming reaches two thousand feet, but it thins out gradually to the eastward, so as to have a thickness on the White River of about one hundred and fifty feet, according to Hayden.

This formation was referred to the Pliocene series by King and Hayden, and I have called it Upper Miocene. The latter view is supported by the presence of the following European Miocene genera and species: Cosoryx, Palæomeryx (= Blastomeryx); Castor div. Steneofiber; *Mastodon* (*Tetrabelodon*) *angustidens*. The remaining Oreodontidæ (Merychyus) give it a facies older than Pliocene.

This series has received the name of Niobrara[66] from Marsh, a term previously applied to a division of the Cretacic. It includes the Humboldt,[67] and probably the North Park formations of King.[68]

PLIOCENE.

Under this head I include everything between the Miocene and the glacial epoch. It includes the following divisions. Two of them are consecutive in time, viz.:

Equus beds,
Idaho.

Two others are probably contemporary with one or both of the preceding, so that the names have only a provisional utility.

Megalonyx beds.

Truckee.

IDAHO.[69]—Present: Mammals, Camelidæ, *Equus excelsus;* Fishes, Cobitidæ, Percidæ, Siluridæ, Raiidæ, Mylocyprinus (Cyprinidæ), and peculiar species of existing genera of Cottidæ, of Salmonidæ, Catostomidæ, and Cyprinidæ. Absent: mammals, *Elephas primigenius*, etc.

The Mammalian fauna of this epoch is little known, owing to the rarity of remains. Its characters may be chiefly learned from the numerous fresh-water fishes it contains, by which it may be compared with the Equus beds, which also contain many fish remains. But one area of this epoch is known. It covers the southern part of Western Idaho, entering Eastern Oregon.

TRUCKEE.—The typical locality of this formation is the Kawsoh Mountains in Western Nevada. The formation was supposed by King to be identical with the John Day Miocene, but Dr. C. A. White informs me that it is of much later age. Vertebrate remains have been found, but have not been fully determined. Thickness (King), two thousand three hundred feet.[70]

EQUUS BEDS.[71]—Present: Glyptodontidæ (Mexico), Megatheriidæ, Eschatiidæ; extinct genera, Holomeniscus, Mastodon (Mexico), Smilodon (Texas); extinct species, *Elephas primigenius;* Equus, four species; Lutra, Cervus, etc.; recent species of Thomomys, Arvicola, Castor, Canis, ? Homo. Absent: Cosoryx, Oreodontidæ, Protolabididæ; Raiidæ, Cobitidæ, Mylocyprinus, and the fishes of the Idaho beds in general; Castoroides and Amblyrhiza.[72]

The localities of this formation are widely distributed. In the presence of various extinct forms, above mentioned, it agrees with the Pampean fauna of South America, but differs in the presence of the northern existing genera and species with the extinct *Elephas primigenius.* The Argentine forms drop off successively as we travel northwards. Thus, Macrauchenia ceases in Bolivia, Toxodon in Nicaragua (Leidy), Glyptodon in the valley of Mexico (Barcena), where *Elephas primigenius* commences. Where the line should be drawn between the Pampean and Equus beds I do not know, but we can arbitrarily assume it to be the line of distribution of the *Elephas primigenius.* This will include the fauna of the valley of Mexico, which has also other forms common to the more northern areas. Such are four species of Equus,—one of Bos, one of Eschatius, one of Holomeniscus (Camelidæ), and one of Platygonus.

The areas of the Equus beds are, then, the valley of Mexico,[73] Southwest Texas,[74] Carson, Nevada,[75] near Fresno, Southern California, the Oregon Desert,[76] Western Nebraska, and probably other localities. The beds are nowhere of great depth.

The presence of Homo in the beds of this epoch in Oregon was indicated by me in 1878.[77] This discovery has been confirmed by the discovery of obsidian implements in place, in Western Nevada, as affirmed in a recent publication[78] of Mr. G. K. Gilbert of the United States Geological Survey in *Nature*. This gentleman has expressed the belief that the beds of this age are not older than the glacial epoch, because they embrace the bases of some of the moraines of some of the ancient glaciers of the Sierra Nevada. It remains to be proven, however, that these moraines are of true glacial age, since they are of entirely local character. The presence of so many mammals of the fauna of the valley of Mexico would not support the belief in a cold climate.

THE MEGALONYX BEDS.[72]—This formation is chiefly represented in the caves of the Eastern States. Its fauna is as follows: Present: Megatherium, Mylodon, Megalonyx, Castoroides, Amblyrhiza, Anomodon, Arctotherium, Smilodon, Platygonus, Mastodon, of extinct genera; and of recent genera, Sciurus, Arctomys, Jaculus, Arvicola, Erethizon, Hydrochœrus, Lagomys, Lepus, Scalops, Procyon, Canis, Mustela, Equus, Tapirus, Dicotyles, Cariacus, Bos, Didelphys. Absent: Glyptodontidæ, *Equus crenidens*, *occidentalis*, and *barcenæi;* Eschatiidæ, Holomeniscus.

It is not certain that this fauna does not owe its peculiarities to geographical causes only, and was not entirely cotemporaneous with the epoch of the Equus beds. Its relations to that of the glacial epoch are not yet fully defined.

PLISTOCENE SYSTEM.

This system is represented by but few deposits in the interior of North America. Therefore it is touched on but lightly in this report. The consecutive epochs which it embraces are the following:

Later Glacial,
Champlain,
Early Glacial.

The faunæ of these periods have not yet been discriminated. As the Champlain was a time of submergence, the species of marine vertebrata may be properly attributed to it. Characteristics of the Plistocene fauna are the following: Present: *Mastodon americanus*, *Cervalces americanus*, *Beluga vermontana*, *Trichechus rosmarus*, *Rangifer tarandus*, *Ovibos bombifrons*, *Bos americanus*, *?Felis atrox*, *Canis lupus*, *Ursus horribilis*, *Mallotus villosus*. Absent: Megatheriidæ, Tapirus, Dicotyles, Platygonus, Amblyrhiza, Arctotherium, Smilodon.

The localities at which fossils of the glacial epoch occur are scattered over the entire continent east of the Plains, and their equivalents occur of course over the west. Many questions of exact contemporaneity of these different beds are as yet unsettled.

TOTAL THICKNESS of the Cænozoic Realm:

	Feet.
Eocene	12,000
Miocene	7,000
Pliocene	? 1,000
Plistocene	? 1,000
	21,000

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EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

To the student of natural science to-day a knowledge of German has become all-important. He *must* read the productions of our Teutonic cousins. Possibly next in importance of foreign tongues comes French, but there are many others of which one must have at least a smattering. There is, however, a limit to the linguistic attainments of the student of science, and soon some International Scientific Congress will have to decide the question of what language or languages shall be recognized. Every year sees the establishment of new journals in what might be termed "outlandish" tongues. The languages of Scandinavia are bad enough, but what shall we do with the facts buried in Russian, Finnish, Polish, Bohemian, and Hun-